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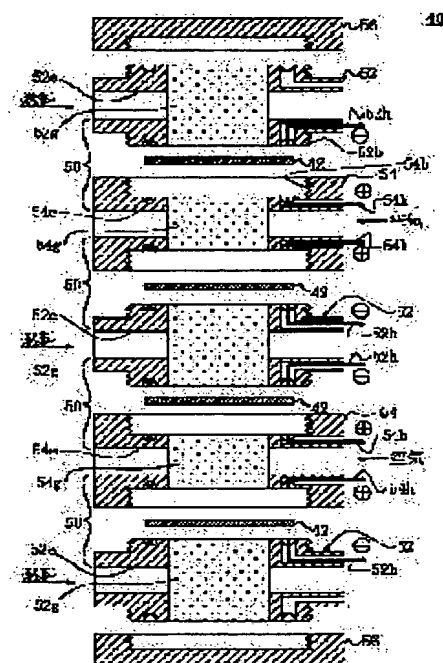
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(54) SOLID POLYMERIC FUEL CELL

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a solid polymeric fuel cell allowing an easy assembly work, enabling uniform tightening pressure to be applied to each unit cell and further allowing an easy maintenance work.

SOLUTION: An electrode-electrolyte jointed body 42 with a pair of gas diffusion electrodes jointed to both surfaces of a solid polymeric electrolyte film, is clamped with a projected clumper 52 having a gas flow passage 52e and a recessed clumper 54 having another gas flow passage 54e. In addition, the adjacent projected and recessed clumpers 52 and 54 are tightened to each other by a screwing means using a screw, thereby forming a unit cell 50. This process is further repeated for providing a solid polymeric fuel cell 40 having a preset number of unit cells 50 stacked.



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CLAIMS

[Claim(s)]

[Claim 1] The polymer electrolyte fuel cell characterized by having the electrode and the electrolyte zygote to which the gas diffusion electrode of a pair was joined by both sides of a solid-state polyelectrolyte, the pinching object equipped with the gas passageway which pinches this electrode and electrolyte zygote, and constitutes a cell, and a mechanical connection means to connect said adjoining pinching objects according to an individual.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the suitable polymer electrolyte fuel cell for the small electric organ of the source of mounted power, and a fixed mold etc. in more detail about a polymer electrolyte fuel cell.

[0002]

[Description of the Prior Art] A polymer electrolyte fuel cell is a fuel cell which uses the solid-state polyelectrolyte film (only henceforth an "electrolyte membrane") as an electrolyte, and since it has the descriptions, like that power density is high, that structure is simple, that operating temperature is comparatively low, and there is silence, it is used as a power source the object for space development, or military from the former. Moreover, when hydrogen is used as a fuel, since it essentially does not discharge nitrogen oxides and carbon dioxide gas, the fuel cell attracts attention also as a source of low-pollution power for automobiles in recent years.

[0003] An example of the basic structure of a polymer electrolyte fuel cell is shown in drawing 8. In drawing 8, the cell 2 used as the generation-of-electrical-energy unit of a polymer electrolyte fuel cell has taken the structure which inserted into both sides of an electrolyte membrane 12 the electrode and the electrolyte zygote 10 which joined the gas diffusion electrodes 14 and 16 of a pair with separators 18 and 18.

[0004] The fluorine system electrolyte membrane with a thickness of 50-200 micrometers generally represented by the perfluoro sulfonic-acid film known for the trade name of Nafion (a trademark, Du Pont make) is used for the electrolyte membrane 12.

[0005] Moreover, gas diffusion electrodes 14 and 16 consist of a catalyst bed (not shown) of the porosity which consists of a carbon particle which made electrode catalysts, such as platinum, support, and an electrolyte, and two-layer [of the diffusion layer (not shown) which consists of a porous material which can diffuse gas].

[0006] Furthermore, separators 18 and 18 have the high current collection engine performance, and, generally the graphite of the stable substantia compacta is used also under an oxidation steam ambient atmosphere. Moreover, Yamabe 18a for supplying an electron to gas diffusion electrodes 14 and 16 and slot 18b for supplying matter, such as gas and water, are prepared in separators 18 and 18.

[0007] It is in the condition which connected the load to the both ends of the cell 2 which has such structure, and if the gas which contains oxygen, such as air, in the sink and gas diffusion electrode 16 (air pole) side of another side for the gas which contains hydrogen, such as reformed gas, in one gas diffusion electrode 14 (fuel electrode) side is passed, water will generate from hydrogen and oxygen and the free energy change in that case will be directly taken out from the separators 18 and 18 allotted to the both ends of a cell 2 as electrical energy.

[0008] By the way, the electromotive force of the cell 2 shown in drawing 8 is before and after 1V, and practical use cannot be presented with it if it remains as it is. Therefore, in order to obtain a high power electrical potential difference, practical use is usually presented as the aggregate of a fuel cell which carried out the hundreds cel laminating of the cell 2 to the serial, attached the equipment which bundles up receipts and payments of a fuel, air, and cooling water to this, and performs them to it, and was dedicated in the container, and the so-called fuel cell stack.

[0009] An example of stack structure is shown in drawing 9. In drawing 9, while the fuel cell stack 20 carries out the hundreds cel laminating of the cell 2 shown in drawing 8, it has arranged the cooling plate 22 for holding a cell 2 to optimum temperature for every number cel, and has taken the structure of the cell 2 by which the laminating was carried out further which allotted clamping plates 24 and 24 up and down.

[0010] Moreover, between the vertical edge of the cell 2 by which the laminating was carried out, and clamping plates 24 and 24, the electric insulating plates 32 and 32 for securing the terminal assemblies 30 and 30 for taking out the generated electrical and electric equipment and an insulation are arranged. Furthermore, the air manifolds 36 and 36 for supplying the fuel manifolds 34 and 34 for supplying fuel gas and air are formed in the side face of the fuel cell stack 20.

[0011] And the assembly of the fuel cell stack 20 is performed by inserting the cell 2 and 2 -- by which the

laminating was carried out by the clamping plates 24 and 24 of two sheets, and binding two or more bolts 26 and 26 — tight collectively by through, the nut 28, and 28 -- to the up-and-down clamping plates 24 and 24.

[0012]

[Problem(s) to be Solved by the Invention] However, as shown in drawing 9 , an electrode and the electrolyte zygote, the separator, the terminal assembly, the cooling plate, etc. carried out the laminating of many members, in the fuel cell stack of the conventional type collectively bound tight with a bolt, many processes were needed for the assembly and there was a problem that a manufacturing cost became high.

[0013] Moreover, although the electrode and the electrolyte zygote, and the separator needed to be bound tight by the uniform bolting pressure in order to make electric contact between an electrolyte membrane and a gas diffusion electrode into a positive thing while preventing the gas leakage from a separator, by the approach of binding tight collectively the layered product of the fuel cell which carried out the hundreds cel laminating of the cell, it bound tight for every cell, dispersion arose to the pressure, and there was a problem that uniform bolting was difficult.

[0014] Since the laminating of the cell is carried out to a serial and a fuel cell stack is a thing, when abnormalities generate it in one cell, the whole fuel cell stack stops furthermore, operating. In that case, the bolt was removed, the whole fuel cell stack was decomposed, after exchanging an abnormal cell for a normal cell, the whole fuel cell stack needed to be assembled again and there was a problem that a maintenance service was complicated.

[0015] The technical problem which this invention tends to solve can give a uniform bolting pressure to each cell, and is for a maintenance service to offer an easy polymer electrolyte fuel cell moreover while it can perform assembly operation easily.

[0016]

[Means for Solving the Problem] The polymer electrolyte fuel cell built over this invention in order to solve the above-mentioned technical problem makes it a summary to have the electrode and the electrolyte zygote to which the gas diffusion electrode of a pair was joined by both sides of a solid-state polyelectrolyte, the pinching object equipped with the gas passageway which pinches this electrode and electrolyte zygote, and constitutes a cell, and a mechanical conclusion means to connect said adjoining pinching objects according to an individual.

[0017] Although it is not limited especially if it is the means which can perform reversibly the adjoining conclusion and separation of pinching objects (it serves as a separator) as a mechanical conclusion means here, a screwing means to conclude the pinching object itself by the male screw, the female screw, and nothing and a screw stop is suitable. Moreover, while preparing a projection in one pinching object, a fitting means to conclude by establishing the slot which engages with the projection in the pinching object of another side, and inserting a projection and a slot in it may be used.

[0018] According to the polymer electrolyte fuel cell concerning this invention which has the above-mentioned configuration, the conclusion activity of a cell is done by concluding pinching objects with a mechanical conclusion means while pinching one an electrode and an electrolyte zygote with the pinching object of a pair.

[0019] What is necessary is to be the repeat of this activity, to arrange an electrode and an electrolyte zygote between the already concluded pinching object and a new pinching object, to conclude the already concluded pinching object and a new pinching object with a mechanical conclusion means, and just to unify, even if it is the case where the hundreds cel laminating of the cell is carried out.

[0020] According to this invention, since conclusion of one electrode and an electrolyte zygote is performed by 1 time of the conclusion process, as compared with the conventional approach, the assembly of a fuel cell becomes easy, and a man day can also be lessened and can manufacture a polymer electrolyte fuel cell by low cost.

[0021] Moreover, since conclusion of an electrode and an electrolyte zygote is performed for every time, it becomes possible to bind each electrode and electrolyte zygote tight by the uniform pressure, and the property difference between cells decreases. Furthermore, since only the electrode and electrolyte zygote which canceled conclusion of the pinching object of the part which abnormalities generated, and abnormalities generated can be removed when abnormalities occur in some cells after assembling a fuel cell stack, a maintenance service is easy-ized.

[0022]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained to a detail, referring to a drawing. Drawing 1 is the decomposition sectional view of the polymer electrolyte fuel cell concerning the gestalt of operation of the 1st of this invention. The polymer electrolyte fuel cell 40 is equipped with an electrode and the electrolyte zygote 42, the pinching object (this is hereafter called "convex type pinching object") 52 that has heights 52b to both ends, the pinching object (this is hereafter called "concave pinching object") 54 which has crevice 54b to both ends, and the terminal assembly 56 in drawing 1 .

[0023] The convex type pinching object 52 and the concave pinching object 54 are arranged by turns toward the direction of a laminating of an electrode and the electrolyte zygote 42. Moreover, heights 52b of the adjoining convex type pinching object 52 and crevice 54b of the concave pinching object 54 can be concluded and unified

now with a mechanical conclusion means. In the polymer electrolyte fuel cell 40 illustrated to drawing 1 , the screwing means by the screw stop is used as a mechanical conclusion means.

[0024] Moreover, an electrode and the electrolyte zygote 42 are pinched between the heights 52b apical surface of the convex type pinching object 52, and the crevice 54b base of the concave pinching object 54, and one cell 50 is constituted by the convex type pinching object 52, an electrode and an electrolyte zygote 42, and the concave pinching object 54. Furthermore, the terminal assembly 56 for taking out the electrical and electric equipment generated with the electrode and the electrolyte zygote 42 is attached in the heights 52 of the convex type pinching object 52 arranged on both ends.

[0025] In addition, what is necessary is to be also the same as when carrying out the five or more layer laminating of the cell 50, to arrange the convex type pinching object 52 and the concave pinching object 54 by turns according to the number of laminatings of a cell 50, and just to arrange an electrode and the electrolyte zygote 42 in the polymer electrolyte fuel cell 40 illustrated to drawing 1 , between the convex type pinching object 52 and the concave pinching object 54, although the cell 50 has structure by which the four-layer laminating was carried out.

[0026] An electrode and the electrolyte zygote 42 join a gas diffusion electrode 46 to both sides of an electrolyte membrane 44, as shown in drawing 2 . As an electrolyte membrane 44, various kinds of electrolyte membranes which have proton conductivity can be used, and it is not limited especially. Generally, the fluorine system electrolyte membrane with a thickness of 50–200 micrometers represented by the perfluoro sulfonic-acid film is used.

[0027] Since it is the copolymer of the perfluoro vinyl ether and tetrafluoroethylene which have a sulfonic group as an electrolyte radical, it has high proton conductivity and it moreover excels in oxidation resistance, the object for prizes of the perfluoro sulfonic-acid film is carried out as an electrolyte membrane for polymer electrolyte fuel cells.

[0028] Moreover, the gas diffusion electrode 46 consists of two-layer [of diffusion layer 46b of the porosity set to the carbon particle which made electrode catalysts, such as platinum, support, and catalyst bed 46a of the porosity which consists of electrolytes, such as a perfluoro sulfonic-acid polymer, from carbon paper, a carbon cross, etc.].

[0029] The convex type pinching object 52 is housing 52a and 52g of gas transparency objects from 52h of lead wire, as shown in drawing 3 . Housing 52a becomes the base material of the convex type pinching object 52, and heights 52b is formed in the both-ends side of a disc-like base material.

[0030] The male screw for concluding with the concave pinching object 54 is formed in the lateral surface of heights 52b. Moreover, lead-wire laying-under-the-ground slot 52c is prepared in the end face of each heights 52b, and lead-wire laying-under-the-ground slot 52c is connected with 52d of lead-wire drawer holes prepared in the side face of housing 52a.

[0031] Gas-passageway 52e penetrated in accordance with radial is prepared in the interior of housing 52a, and reactant gas can be passed now in gas-passageway 52e. Furthermore, in accordance with shaft orientations, 52f of cylinder-like through holes is prepared in the center of housing 52a so that it may intersect perpendicularly with gas-passageway 52e.

[0032] Here, the ingredient which has the thermal resistance of extent which does not deform in the operating temperature region (before or after 80 degrees C) of a polymer electrolyte fuel cell 40, and insulation is used for housing 52a. Specifically, polytetrafluoroethylene is mentioned as a suitable example. Thermal resistance is needed for controlling deformation of housing 52a and preventing the fall of the bolting pressure of an electrode and the electrolyte zygote 42, and the fall of the seal nature of reactant gas.

[0033] Moreover, insulation is needed for obtaining a high power electrical potential difference. That is, in order to obtain a high power electrical potential difference, it is necessary to connect each cell 50 to a serial but, and as mentioned later, since it stands in a line in sequence, in the polymer electrolyte fuel cell 40 shown in drawing 1 , a cell 50 is [of (–+), (+–), and – (– +)] to connect like poles and for a fuel cell 40 to connect too hastily, when a conductor is used as housing 52a.

[0034] In addition, when you do not need a high power electrical potential difference, while using conductors, such as stainless steel, for a part of housing 52a, an insulator may be used for other parts, and you may constitute so that parallel connection of the cell 50 may be carried out.

[0035] 52g of gas transparency objects is presenting the cylindrical shape, and they are laid under the 52f of the through holes of housing 52a. Moreover, the reinforcement of extent which is not collapsed when an electrode and the electrolyte zygote 42 are pinched with gas permeability, the convex type pinching object 52, and the concave pinching object 54, and the ingredient which has insulation are used for 52g of gas transparency objects. Specifically, ceramic porous bodies, such as a zirconia, are mentioned as a suitable example.

[0036] Gas permeability is needed for supplying the electrode and the electrolyte zygote 42 which allotted the reactant gas which flows gas-passageway 52e of housing 52a to both sides of housing 52a through 52g of gas transparency objects.

[0037] Therefore, in the polymer electrolyte fuel cell 40 illustrated to drawing 1 , in housing 52a, there is no

function as a separator for preventing mixing of reactant gas, and an electrode and the electrolyte zygote 42 achieve the function as a separator to it.

[0038] Moreover, reinforcement is needed for giving a predetermined bolting pressure to an electrode and the electrolyte zygote 42, in case an electrode and the electrolyte zygote 42 are pinched with the convex type pinching object 52 and the concave pinching object 54. That is, if the reinforcement of 52g of gas transparency objects is low, a bolting pressure cannot be enlarged, but the gas leakage of reactant gas will arise, or it will become inadequate electric contacting an electrolyte membrane 44 and a gas diffusion electrode 46, and generating efficiency will fall.

[0039] Furthermore, insulation is needed for connecting a cell 50 to a serial and securing a high power electrical potential difference like above-mentioned housing 52a. However, when a high power electrical potential difference is not required, 52g of some gas transparency objects is constituted from a conductor which has gas permeability, such as a metal porous body and a layered product of a metal mesh, like housing 52a, and it may be made to carry out parallel connection of the cell 50.

[0040] In addition, since it is sufficient if supply of reactant gas is possible for 52g of gas transparency objects to an electrode and the electrolyte zygote 42, the configuration of 52g of gas transparency objects is not limited to the ceramic porous body of a cylindrical shape so that it may illustrate to drawing 3.

[0041] For example, what prepared the through hole in the side face of the ceramic porous body of a cylindrical shape along with the gas flow direction as 52g of gas transparency objects may be used. When a through tube is prepared along with a gas flow direction, there is an advantage that pressure loss can be reduced. Moreover, it considers as the shape of so-called rib which put side by side the slot of a large number penetrated along with a gas flow direction, using the ingredient of the substantia compacta as 52g of gas transparency objects, and you may make it support an electrode and the electrolyte zygote 42 at Yamabe's tip.

[0042] By making the gas diffusion electrode 46 joined to the electrolyte membrane 44 contact, 52h of lead wire is for taking out the electrical and electric equipment generated with the electrode and the electrolyte zygote 42, and they is laid under the lead-wire laying-under-the-ground slot 52c prepared in the end face of heights 52b of housing 52a. Moreover, the edge of 52h of lead wire is pulled out out of housing 52a from 52d of lead-wire drawer holes prepared in the side face of housing 52a.

[0043] The ingredient excellent in corrosion resistance is used as the quality of the material of 52h of lead wire. Specifically, what covered Sn or Sn alloy is mentioned to metal lead wire, such as stainless steel, Sn, Sn alloy or stainless steel, and copper, as a suitable example.

[0044] Although the reactant gas with which needing corrosion resistance is supplied to a polymer electrolyte fuel cell 40 is usually humidified in order to supply water to an electrolyte membrane 44, and 52h of lead wire is put to the bottom of an oxidation steam ambient atmosphere, 52h of lead wire is [oxidation and] for contact resistance with a gas diffusion electrode 46 to increase, and for generating efficiency to fall by the oxidation steam, when passivation is carried out.

[0045] The concave pinching object 54 is housing 54a and 54g of gas transparency objects from 54h of lead wire, as shown in drawing 4. Housing 54a becomes the base material of the concave pinching object 54, and crevice 54b is formed in the both-ends side of a disc-like base material. Moreover, a female screw is formed in the medial surface of crevice 54b, and the concave pinching object 54 and the convex type pinching object 52 can be mechanically concluded and united now with it by screwing with the male screw formed in the lateral surface of heights 52a of the convex type pinching object 52.

[0046] Moreover, the bore of crevice 54b of housing 54a is a little larger than the outer diameter of an electrode and the electrolyte zygote 42, and can hold now an electrode and the electrolyte zygote 42 in crevice 54b.

[0047] Furthermore, when the concave pinching object 54 and the convex type pinching object 52 are concluded, space is formed between the base of crevice 54b, and the apical surface of heights 52b, but as for the height of the space, the predetermined bolting pressure has become small a little from the height of an electrode and the electrolyte zygote 42 so that may be given to the electrode and the electrolyte zygote 42 pinched in the space.

[0048] in addition, in the base of crevice 54b of housing 54a Inside a point connected to 54d of lead-wire drawer holes which lead-wire laying-under-the-ground slot 54c is prepared, and are prepared in the side face of housing 54a, and housing 54a The point that gas-passageway 54e penetrated in accordance with radial is prepared, the point that 54f of through tubes is prepared in accordance with shaft orientations, and the point that polytetrafluoroethylene is desirable as the quality of the material of housing 54a are the same as that of housing 52a of the convex type pinching object 52.

[0049] moreover, as the point that 54g of gas transparency objects is laid under the 54f of the through tubes of housing 54a, and the quality of the material which is 54g of gas transparency objects As the point that ceramic porous bodies, such as a zirconia, are desirable, the point that 54h of lead wire is laid under the lead-wire laying-under-the-ground hole 54c, and the quality of the material that is 54h of lead wire The point for metal wires, such as stainless steel, Sn, Sn alloyed wire or stainless steel, and copper, that what covered Sn or Sn alloy is suitable is the same as that of the convex type pinching object 52.

[0050] As a terminal assembly 56 is shown in drawing 5, female screw 56a is prepared so that it can screw with

heights 52b of the convex type pinching object 52 arranged to the both ends of the cell 50 by which the laminating was carried out. Moreover, conductive ingredients, such as stainless steel and copper, are used for a terminal assembly 56.

[0051] In addition, since it is sufficient if the electrical and electric equipment generated with each electrode and electrolyte zygote 42 can be taken out, it is not necessary to make a terminal assembly 56 not necessarily screw with the convex type pinching object 52, and you may make it only insert it in. Moreover, when one edge of the layered products of a cell 50 is the concave pinching object 54, what prepared the heights in which the female screw of crevice 54b, the male screw which can be screwed, or fitting is possible may be used as a terminal assembly 56.

[0052] Next, the assembly procedure of the polymer electrolyte fuel cell 40 shown in drawing 1 is explained. First, an electrode and the electrolyte zygote 42 are held in crevice 54b of the concave pinching object 54 with which 54g of gas transparency objects and 54h of lead wire were laid underground. Subsequently, what is necessary is to make crevice 54b of the concave pinching object 54 face heights 52b of the convex type pinching object 52 with which 52g of gas transparency objects and 52h of lead wire were similarly laid underground, and just to screw heights 52b and crevice 54b.

[0053] Thereby, as for an electrode and the electrolyte zygote 42, a predetermined bolting pressure is given to homogeneity by the apical surface of heights 52b, and the base of crevice 54b. Moreover, at this time, the lead wire 52h and 54h laid under the lead-wire laying-under-the-ground holes 52c and 54c and the gas diffusion electrodes 46 and 46 of an electrode and the electrolyte zygote 42 contact, and it becomes one cell 50.

[0054] the heights 52 of another convex type pinching object 52 are made to screw in crevice 54b which holds an electrode and the electrolyte zygote 42 in crevice 54b of another side of the concave pinching object 54 which is the same also as for the conclusion activity of the cell 50 after the 2nd, and was already concluded and by which the electrode and the electrolyte zygote 42 were held in it -- being sufficient . And if a terminal assembly 56 is screwed in both ends after carrying out the laminating of the cell 50 of a predetermined number, the layered product of a cell 50 will be obtained.

[0055] Next, lead wire [52h and 54h] connection is performed. Usually, each cell 50 is connected to a serial so that a high power electrical potential difference may be obtained. Since in the case of the polymer electrolyte fuel cell 40 illustrated to drawing 1 fuel gas is passed to gas-passageway 52e of the convex type pinching object 52 and air is passed to gas-passageway 54e of a sink and the concave pinching object 54, the gas diffusion electrode 46 which touches the convex type pinching object 52 serves as an anode (− pole), and the gas diffusion electrode 46 which touches the concave pinching object 54 serves as a cathode (+ pole).

[0056] That is, like poles adjoin each other like (−+), (+−), and −− (− +) in a cell 50. therefore, in order to connect a cell 50 to a serial To the upside terminal assembly 56, it connects with 52h of lead wire by the side of the anode of the cell 50 located in the topmost part, and considers as − pole. For example, to the lower terminal assembly 56 What is necessary is to connect with 54h of lead wire by the side of the cathode of the cell 50 located in the bottom, to consider as + pole, and just to connect the remaining lead wire 52h and 54h so that each cell 50 may be further connected in order of (+−), (+−), and −−.

[0057] If a fuel manifold (not shown) is attached in 52g of gas passageways and an air manifold (not shown) is finally attached in 54g of gas passageways, a polymer electrolyte fuel cell 40 will be completed.

[0058] If the fuel gas and air containing hydrogen, such as reformed gas, are passed to the gas passageways 52e and 54e of a polymer electrolyte fuel cell 40 which have such a configuration, a fuel will be supplied to the gas diffusion electrode 46 which is in contact with heights 52b, and air will be supplied to the gas diffusion electrode 46 which is in contact with crevice 54b at them, respectively. Thereby, electrode reaction advances in each electrode and electrolyte zygote 42, and the obtained electrical and electric equipment is taken out outside through terminal assemblies 56 and 56.

[0059] In addition, although lead wire [52h and 54h] connection sequence may be changed when carrying out parallel connection of some each cell 50, a conductor is used for a Housings 52a and 54a and gas transparency objects [52g and 54g] part, and you may make it connect a part of like poles. In this case, since Housings 52a and 54a and the gas transparency objects 52h and 54h play the role of lead wire, lead wire 52h and 54h is unnecessary.

[0060] Moreover, what is necessary is for a procedure contrary to **** just to perform, in decomposing the assembled fuel cell. Furthermore, what is necessary is to remove only the pinching objects 52 and 54 which constitute the cell 50 to exchange, in exchanging only some cells 50.

[0061] Next, the polymer electrolyte fuel cell concerning the gestalt of operation of the 2nd of this invention is explained. Drawing 6 is the decomposition sectional view of the polymer electrolyte fuel cell 60 concerning the gestalt of operation of the 2nd of this invention. The polymer electrolyte fuel cell 60 is equipped with the electrode and the electrolyte zygote 42, and the pinching object 62 that has heights 62b in one field, and has 62d of crevices in the field of another side in drawing 6 .

[0062] The polymer electrolyte fuel cell 60 has the structure where the laminating of an electrode and the electrolyte zygote 42, and the pinching object 62 was carried out by turns toward the direction of a laminating.

Moreover, while adjoins, and heights 62b of the pinching object 62 and 62d of crevices of the pinching object 62 of another side can be concluded and unified now with a mechanical conclusion means. In the polymer electrolyte fuel cell 60 illustrated to drawing 6, the screwing means by the screw stop is used as a mechanical conclusion means.

[0063] Moreover, an electrode and the electrolyte zygote 42 are pinched between the heights 62b apical surface of one pinching object 62, and 62d base of crevices of the pinching object 62 of another side, and one cell 50 is constituted by two pinching objects 62 and 62, and an electrode and an electrolyte zygote 42. In addition, in the polymer electrolyte fuel cell 60 illustrated to drawing 6, although the cell 50 has structure by which the four-layer laminating was carried out, it is also the same as when carrying out the five or more layer laminating of the cell.

[0064] Since the electrode and the electrolyte zygote 42 have the same configuration as what is shown in drawing 2, it omits explanation. Moreover, the pinching object 62 is equipped with housing 62a and the gas transparency objects 62i and 62j as shown in drawing 7.

[0065] Insulating-layer 62c is prepared in heights 62b prepared in one field of housing 62a, and the part, lateral surface, and basal plane of an apical surface of heights 62b are covered with it by insulating-layer 62c. This is for contacting the heights 62b apical surface and gas diffusion electrode 46 which are not covered with insulating-layer 62c at the same time it secures the insulation of the pinching object 62 and 62 comrades, when the pinching object 62 and 62 comrades are screwed. Moreover, the male screw is formed in the peripheral face of insulating-layer 62c.

[0066] Moreover, the male screw and the female screw which can be screwed formed in the peripheral face of insulating-layer 62c are formed in the inner skin of 62d of crevices established in the field of another side of housing 62a. Moreover, the outer diameter of 62d of crevices is a little larger than the outer diameter of an electrode and the electrolyte zygote 42, and can hold now an electrode and the electrolyte zygote 42 in 62d of crevices.

[0067] Furthermore, when two pinching objects 62 and 62 are concluded, space is formed between the base of 62d of crevices, and the apical surface of heights 62b, but as for the height of the space, the predetermined bolting pressure has become small a little from the height of an electrode and the electrolyte zygote 42 so that may be given to the electrode and the electrolyte zygote 42 pinched in the space.

[0068] It penetrates in the interior of housing 62a toward radial, and two gas passageways 62e and 62f which cross mutually are formed in it, and fuel gas can be passed to one side and they can pass oxidant gas now on another side. Therefore, in the case of the gestalt of this operation, like (+-) and -- (+-), the laminating of the cell 50 is carried out so that unlike poles may adjoin each other. Moreover, the pinching object 62 also achieves the function as a separator.

[0069] Furthermore, gas-passageway 62e and 62g of gas transparency object laying-under-the-ground holes open for free passage are prepared in the heights 62b side of housing 62a, and 62f of gas passageways and 62h of gas transparency object laying-under-the-ground holes open for free passage are prepared in 62d side of crevices of housing 62a.

[0070] Here, the ingredient which has conductivity and corrosion resistance is used for housing 62a. Specifically, what covered Sn or Sn alloy is mentioned to the base material which consists of stainless steel, Sn, Sn alloy or stainless steel, copper, etc. as a suitable example.

[0071] Conductivity is needed for connecting electrically the gas diffusion electrodes 46 and 46 of the electrode and the electrolyte zygotes 42 and 42 arranged to the both ends of the pinching object 62, and connecting a cell 50 to a serial. Therefore, in the case of the pinching object 62 shown in drawing 7, unlike the pinching objects 52 and 54 shown in drawing 3 and drawing 4, lead wire is unnecessary.

[0072] Moreover, corrosion resistance is needed oxidation and for contact resistance with a gas diffusion electrode 46 increasing, and generating efficiency falling by putting housing 62a to the bottom of an oxidation steam ambient atmosphere, when passivation is carried out.

[0073] The ingredient which has the thermal resistance of extent which can maintain an insulating property also with the operating temperature (before or after 80 degrees C) of a polymer electrolyte fuel cell 60 is used for insulating-layer 62c prepared in heights 62b of housing 62a. Specifically, polytetrafluoroethylene is mentioned as a suitable example. Moreover, what is necessary is just to fix housing 62a and insulating-layer 62c using means, such as a screw stop, a bolt stop, and fitting.

[0074] The gas transparency objects 62i and 62j are presenting the cylindrical shape, and are laid under the gas transparency object laying-under-the-ground holes 62g and 62h prepared in housing 62a, respectively. Moreover, the through tubes 62k and 62l penetrated toward gas-passageway 62e and the direction of 62f are formed in the gas transparency objects 62i and 62j, respectively.

[0075] Here, the ingredient which has the reinforcement of extent which is not collapsed when the electrode electrolyte zygote 42 is pinched with gas permeability and two pinching objects 62 and 62 is used for the gas transparency objects 62i and 62j. Needing gas permeability and reinforcement is based on the same reason as the gas transparency objects 52g and 54g used for the pinching objects 52 and 54 shown in drawing 3 and

drawing 4 .

[0076] however, since the laminating of the cell 50 is carried out in the sequence of (+-) and -- (+-) in the case of the gestalt of this operation, the gas transparency objects 62i and 62j are insulators -- it is not required and a conductor may be used. Specifically, ceramic porous bodies, such as a zirconia, a metal porous body, the layered product of a metal mesh, etc. can be used.

[0077] In addition, the point that the thing of the shape of a rib which may use for the gas transparency objects 62i and 62j the porous body which does not have through tubes 62k and 62l., and consists of an ingredient of the substantia compacta may be used is the same as that of the gas transparency objects 52g and 54g shown in drawing 3 and drawing 4 .

[0078] Next, the assembly procedure of the polymer electrolyte fuel cell 60 shown in drawing 6 is explained. First, while was laid underground and the gas transparency objects 62i and 62j hold an electrode and the electrolyte zygote 42 in 62d of crevices of the pinching object 62. Subsequently, what is necessary is to make 62d of crevices of one pinching object 62 face heights 62b of the pinching object 62 of another side under which the gas transparency objects 62i and 62j were similarly laid, and just to screw it with heights 62b and 62d of crevices.

[0079] Thereby, as for an electrode and the electrolyte zygote 42, a predetermined bolting pressure is given to homogeneity by the apical surface of heights 62b, and the base of 62d of crevices. Moreover, at this time, the part which is not covered with insulating-layer 62c among the heights 62b apical surfaces of one pinching object 62 and one gas diffusion electrode 46 of an electrode and the electrolyte zygote 42 contact, 62d base of crevices of the pinching object 62 of another side and the gas diffusion electrode 46 of another side of an electrode and the electrolyte zygote 42 contact, and it becomes one cell 50.

[0080] heights 62b of another pinching object 62 is made to screw in 62d of crevices where the electrode and the electrolyte zygote 42 were held in 62d of crevices of the pinching object 62 which is the same also as for the conclusion activity of the cell 50 after the 2nd, and was already concluded, and the electrode and the electrolyte zygote 42 were held in them -- being sufficient .

[0081] Furthermore, if a fuel manifold (not shown) is attached in the last at gas-passageway 62e and an air manifold (not shown) is attached in 62f of gas passageways after carrying out the laminating of the cell 50 of a predetermined number, a polymer electrolyte fuel cell 60 will be completed.

[0082] If the oxidant gas which contains oxygen, such as fuel gas which contains hydrogen, such as reformed gas, respectively, and air, in the gas passageways 62e and 62f of a polymer electrolyte fuel cell 60 which have such a configuration is passed Air is supplied through gas transparency object 62j, and the gas diffusion electrode 46 which fuel gas was supplied through gas transparency object 62i, and the gas diffusion electrode 46 which is in contact with heights 62b became an anode (- pole), and is in contact with 62d of crevices serves as a cathode (+ pole). Thereby, electrode reaction advances in each electrode and electrolyte zygote 42, and the obtained electrical and electric equipment is taken out outside through the pinching objects 62 and 62 made from a conductor arranged on both ends.

[0083] In addition, when exchanging only a point to perform in a procedure contrary to **** when decomposing the assembled fuel cell, and some cells 50, the point that what is necessary is to remove only the pinching objects 62 and 62 which constitute the cell 50 to exchange is the same as the gestalt of the 1st operation.

[0084] As mentioned above, although the gestalt of operation of this invention was explained to the detail, alterations various by within the limits which is not limited to the gestalt of the above-mentioned implementation at all, and does not deviate from the summary of this invention are possible for this invention.

[0085] For example, although each uses the screwing means as a mechanical conclusion means with the gestalt of the above-mentioned implementation While preparing a projection in the heights lateral surface prepared in one pinching object, or the crevice medial surface prepared in the pinching object of another side You may make it conclude adjoining pinching objects by making a projection and a slot engaged at the same time it establishes the slot which engages with the projection in another side and inserts the heights of one pinching object in the crevice of the pinching object of another side.

[0086] Moreover, in the gestalt of the 1st operation, although an electrode and an electrolyte zygote are pinched using the convex type pinching object which prepared heights in both sides, and the concave pinching object which established the crevice in both sides, the pinching object which prepared heights in one field of a housing and established the crevice in the field of another side may be used.

[0087] Moreover, although he is trying to contact ring-like lead wire to an electrode and an electrolyte zygote, a curled form slot is established in the heights 52b tip of a housing and a crevice 54b base, and a list, and you may make it lay a curled form lead wire under the gas transparency objects [52g and 54g] both-ends side in the gestalt of the 1st operation at them. Or the conductor of the shape of a thin layer which has gas permeability, such as a metal mesh, is contacted to both sides of an electrode and an electrolyte zygote instead of lead wire, and you may make it take out the electrical and electric equipment generated through the thin layer-like conductor.

[0088] Moreover, whenever it carries out the number cell laminating of the cell, you may make it arrange a

cooling plate, although the gestalt of the above-mentioned implementation explained the structure where the laminating only of the cell was carried out. Furthermore, with the gestalt of the above-mentioned implementation, although each appearance of a housing is used as the cylindrical shape, it is good also considering the appearance of a housing as other configurations, such as a prismatic form, and, thereby, the same effectiveness as the gestalt of the above-mentioned implementation can be acquired.

[0089]

[Effect of the Invention] Since the fuel cell concerning this invention concluded pinching objects with the mechanical conclusion means while pinching the electrode and the electrolyte zygote with the pinching object equipped with the gas passageway, the hundreds cel laminating of the cell is carried out, an assembly becomes easy as compared with the polymer electrolyte fuel cell of the conventional type collectively bound tight with a bolt, and it can also lessen a man day, and is effective in a manufacturing cost being reducible.

[0090] Moreover, since a bolting activity is done for every electrode and electrolyte zygote, it becomes possible to bind each electrode and electrolyte zygote tight by the uniform pressure, and is effective in the property difference between cells decreasing.

[0091] Furthermore, since only the electrode and electrolyte zygote which canceled conclusion of the pinching object of the part which abnormalities generated, and abnormalities generated can be removed when abnormalities occur in some cells after assembling a fuel cell, it is effective in a maintenance service being easy-ized.

[0092] As mentioned above, it is enabled for this invention to have few property differences between cells, and to manufacture the easy fuel cell of a maintenance service cheaply. Therefore, if this is applied to the fuel cell system for automobiles, it will contribute to the high increase in power of an automobile, and low cost-ization, and will be very large invention of the effectiveness on industry.

[Translation done.]

* NOTICES *

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the decomposition sectional view of the polymer electrolyte fuel cell concerning the gestalt of operation of the 1st of this invention.

[Drawing 2] It is the sectional view of the electrode and electrolyte zygote used for the polymer electrolyte fuel cell shown in drawing 1 .

[Drawing 3] Drawing 3 (a) is the top view of the convex type pinching object used for the polymer electrolyte fuel cell shown in drawing 1 , and drawing 3 (b) is the A-A' line sectional view.

[Drawing 4] Drawing 4 (a) is the top view of the concave pinching object used for the polymer electrolyte fuel cell shown in drawing 1 , and drawing 4 (b) is the A-A' line sectional view.

[Drawing 5] Drawing 5 (a) is the top view of the terminal assembly used for the polymer electrolyte fuel cell shown in drawing 1 , and drawing 5 (b) is the A-A' line sectional view.

[Drawing 6] It is the decomposition sectional view of the polymer electrolyte fuel cell concerning the gestalt of operation of the 2nd of this invention.

[Drawing 7] Drawing 7 (a) is the top view of the pinching object used for the polymer electrolyte fuel cell shown in drawing 6 , drawing 7 (b) is the A-A' line sectional view, and drawing 7 (c) is the B-B' line sectional view.

[Drawing 8] It is the decomposition perspective view of the cell used as the generation-of-electrical-energy unit of a polymer electrolyte fuel cell.

[Drawing 9] It is the perspective view showing the stack structure of the fuel cell generally used conventionally.

[Description of Notations]

40 60 Polymer electrolyte fuel cell

42 Electrode and Electrolyte Zygote

44 Solid-state Polyelectrolyte Film (Electrolyte Membrane)

46 Gas Diffusion Electrode

50 Cell

52 Pinching Object (Convex Type Pinching Object)

52e Gas passageway

54 Pinching Object (Concave Pinching Object)

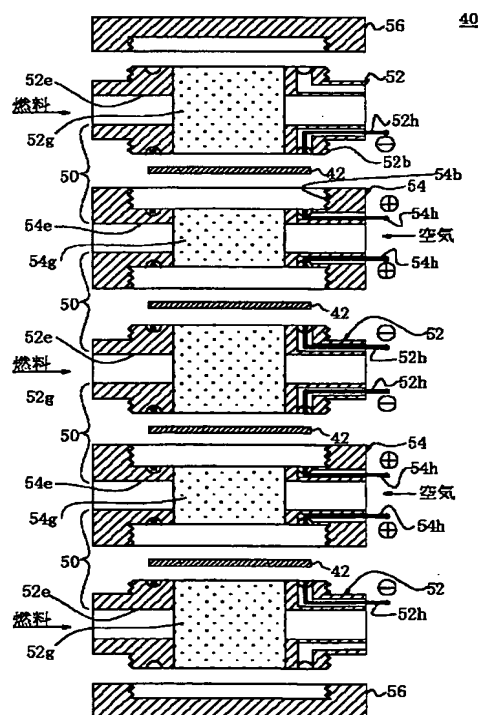
54e Gas passageway

62 Pinching Object

62e, 62f Gas passageway

[Translation done.]

(11)特許出願公開番号
特開2000-90956
(P2000-90956A)



【特許請求の範囲】

【請求項1】 固体高分子電解質の両面に一對のガス拡散電極が接合された電極・電解質接合体と、該電極・電解質接合体を挟持し、セルを構成するガス流路を備えた挟持体と、隣接する前記挟持体同士を個別に連結する機械的締結手段とを備えていることを特徴とする固体高分子型燃料電池。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、固体高分子型燃料電池に関し、さらに詳しくは、車載動力源、定置型の小型発電器等に好適な固体高分子型燃料電池に関するものである。

【0002】

【従来の技術】固体高分子型燃料電池は、電解質として固体高分子電解質膜（以下、単に「電解質膜」という）を用いる燃料電池であり、出力密度が高いこと、構造が単純であること、動作温度が比較的低いこと、静粛性があること、等の特徴を有していることから、従来から宇宙開発用あるいは軍用の電源として用いられている。また、燃料電池は、水素を燃料として用いた場合には、本質的には窒素酸化物及び炭酸ガスを排出しないことから、近年では、自動車用の低公害動力源としても注目されているものである。

【0003】図8に、固体高分子型燃料電池の基本構造の一例を示す。図8において、固体高分子型燃料電池の発電単位となる単電池2は、電解質膜12の両面に一對のガス拡散電極14、16を接合した電極・電解質接合体10を、セパレータ18、18で挟んだ構造をとっている。

【0004】電解質膜12には、一般に、ナフィオン（登録商標、デュボン社製）の商品名で知られるパーフルオロスルホン酸膜に代表される、厚さ50～200 μ mのフッ素系電解質膜が用いられている。

【0005】また、ガス拡散電極14、16は、白金等の電極触媒を担持させたカーボン粒子と電解質からなる多孔質の触媒層（図示せず）と、ガスが拡散可能な多孔質材料からなる拡散層（図示せず）の2層からなっている。

【0006】さらに、セパレータ18、18は、集電性能が高く、酸化水蒸気雰囲気下でも安定な緻密質のグラファイトが一般に用いられる。また、セパレータ18、18には、ガス拡散電極14、16に電子を供給するための山部18aと、ガスや水などの物質を供給するための溝部18bが設けられている。

【0007】このような構造を有する単電池2の両端に負荷を接続した状態で、一方のガス拡散電極14（燃料極）側に改質ガス等の水素を含むガスを流し、他方のガス拡散電極16（空気極）側に空気等の酸素を含むガスを

を流すと、水素と酸素から水が生成し、その際の自由エネルギー変化が、単電池2の両端に配したセパレータ18、18から直接、電気エネルギーとして取り出されるものである。

【0008】ところで、図8に示す単電池2の起電力は1V前後であり、そのままでは実用に供することができない。そのため、通常は、高出力電圧を得るために、単電池2を直列に数百セル積層し、これに燃料、空気、冷却水の出入りを一括して行う装置を取り付けて容器内に納めた燃料電池の集合体、いわゆる燃料電池スタックとして実用に供されている。

【0009】図9に、スタック構造の一例を示す。図9において、燃料電池スタック20は、図8に示す単電池2を数百セル積層すると共に、単電池2を最適温度に保持するための冷却板22を数セル毎に配置し、さらに積層された単電池2の上下に締付板24、24を配した構造をとっている。

【0010】また、積層された単電池2の上下端と締付板24、24の間には、発電された電気を取り出すための端子板30、30、及び絶縁を確保するための絶縁板32、32が配置されている。さらに、燃料電池スタック20の側面には、燃料ガスを供給するための燃料マニホールド34、34、及び空気を供給するための空気マニホールド36、36が設けられている。

【0011】そして、積層された単電池2、2…を2枚の締付板24、24で挟み、上下の締付板24、24に複数本のボルト26、26…を通し、ナット28、28…で一括して締め付けることにより、燃料電池スタック20の組み立てが行われる。

【0012】

【発明が解決しようとする課題】しかしながら、図9に示すように、電極・電解質接合体、セパレータ、端子板、冷却板等、多数の部材を積層し、ボルトで一括して締め付ける従来型の燃料電池スタックでは、組み立てに多くの工程を必要とし、製造コストが高くなるという問題があった。

【0013】また、セパレータからのガス漏れを防止すると同時に、電解質膜とガス拡散電極との間の電氣的接触を確実なものとするためには、電極・電解質接合体とセパレータとを均一な締め付け圧力で締め付ける必要があるが、単電池を数百セル積層した燃料電池の積層体を一括して締め付ける方法では、各単電池毎に締め付け圧力にばらつきが生じ、均一な締め付けが困難であるという問題があった。

【0014】さらに、燃料電池スタックは、単電池が直列に積層されるものであるため、1つの単電池に異常が発生すると燃料電池スタック全体が作動しなくなる。その場合、ボルトを外して燃料電池スタック全体を分解し、異常のある単電池を正常な単電池に交換した後、再度燃料電池スタック全体を組み立てる必要があり、保守作業

が繁雑であるという問題があった。

【0015】本発明が解決しようとする課題は、組立作業を容易に行うことができると共に、各単電池に均一な締め付け圧力を付与することができ、しかも保守作業が容易な固体高分子型燃料電池を提供することにある。

【0016】

【課題を解決するための手段】上記課題を解決するために本発明に係る固体高分子型燃料電池は、固体高分子電解質の両面に一对のガス拡散電極が接合された電極・電解質接合体と、該電極・電解質接合体を挟持し、セルを構成するガス流路を備えた挟持体と、隣接する前記挟持体同士を個別に連結する機械的締結手段とを備えていることを要旨とするものである。

【0017】ここで、機械的締結手段としては、隣接する挟持体（セパレータを兼ねる）同士の締結及び分離を可逆的に行うことが可能な手段であれば特に限定されるものではないが、挟持体自身を雄ネジ、雌ネジとなし、ネジ止めにより締結する螺合手段が好適である。また、一方の挟持体に突起を設けると共に、他方の挟持体にその突起と係合する溝を設け、突起と溝とを嵌め合わせることに締結する嵌合手段でもよい。

【0018】上記構成を有する本発明に係る固体高分子型燃料電池によれば、単電池の締結作業は、1つの電極・電解質接合体を一对の挟持体で挟持すると共に、機械的締結手段により挟持体同士を締結することにより行われる。

【0019】単電池を数百セル積層する場合であっても、この作業の繰り返しであり、既に締結された挟持体と新たな挟持体との間に電極・電解質接合体を配置し、既に締結された挟持体と新たな挟持体とを、機械的締結手段により締結し、一体化すればよい。

【0020】本発明によれば、1回の締結工程により1個の電極・電解質接合体の締結が行われるので、従来の方法に比較して、燃料電池の組み立てが容易となり、工数も少なくすることができ、低コストで固体高分子型燃料電池を製造できる。

【0021】また、電極・電解質接合体の締結が1回毎に行われるので、各電極・電解質接合体を均一な圧力で締め付けることが可能となり、単電池間の特性差が少なくなる。さらに、燃料電池スタックを組み立てた後、一部の単電池に異常が発生した場合には、異常が発生した部位の挟持体の締結を解除し、異常が発生した電極・電解質接合体のみを取り外すことができるので、保守作業が容易化される。

【0022】

【発明の実施の形態】以下、本発明の実施の形態を図面を参照しながら詳細に説明する。図1は、本発明の第1の実施の形態に係る固体高分子型燃料電池の分解断面図である。図1において、固体高分子型燃料電池40は、電極・電解質接合体42と、両端に凸部52bを有する

挟持体（以下、これを「凸型挟持体」という）52と、両端に凹部54bを有する挟持体（以下、これを「凹型挟持体」という）54と、端子板56とを備えている。

【0023】凸型挟持体52と凹型挟持体54は、電極・電解質接合体42の積層方向に向かって交互に配置されている。また、隣接する凸型挟持体52の凸部52bと、凹型挟持体54の凹部54bとは、機械的締結手段により締結・一体化できるようになっている。図1に例示する固体高分子型燃料電池40においては、機械的締結手段として、ネジ止めによる螺合手段が用いられている。

【0024】また、電極・電解質接合体42は、凸型挟持体52の凸部52b先端面と凹型挟持体54の凹部54b底面との間で挟持されるようになっており、凸型挟持体52、電極・電解質接合体42、及び凹型挟持体54により1つの単電池50が構成される。さらに、両端に配した凸型挟持体52の凸部52には、電極・電解質接合体42で発電された電気を取り出すための端子板56が取り付けられる。

【0025】なお、図1に例示する固体高分子型燃料電池40においては、単電池50が4層積層された構造になっているが、単電池50を5層以上積層する場合も同様であり、凸型挟持体52及び凹型挟持体54を単電池50の積層数に応じて交互に配置し、凸型挟持体52及び凹型挟持体54の間に電極・電解質接合体42を配置すればよい。

【0026】電極・電解質接合体42は、図2に示すように、電解質膜44の両面にガス拡散電極46を接合したものである。電解質膜44としては、プロトン伝導性を有する各種の電解質膜を用いることができ、特に限定されるものではない。一般的には、パーフルオロスルホン酸膜に代表される、厚さ50～200 μ mのフッ素系電解質膜が用いられる。

【0027】パーフルオロスルホン酸膜は、電解質基としてスルホン酸基を有するパーフルオロビニルエーテルとテトラフルオロエチレンとの共重合体であり、高いプロトン伝導性を有し、しかも耐酸化性に優れていることから、固体高分子型燃料電池用の電解質膜として賞用されているものである。

【0028】また、ガス拡散電極46は、白金等の電極触媒を担持させたカーボン粒子と、パーフルオロスルホン酸ポリマー等の電解質からなる多孔質の触媒層46aと、カーボンペーパー、カーボンクロス等からなる多孔質の拡散層46bの2層からなっている。

【0029】凸型挟持体52は、図3に示すように、支持枠52aと、ガス透過体52gと、リード線52hからなっている。支持枠52aは、凸型挟持体52の基材となるものであり、円板状の基材の両端面には、凸部52bが形成されている。

【0030】凸部52bの外側面には、凹型挟持体54

と締結するための雄ネジが設けられている。また、各凸部52bの端面には、リード線埋設溝52cが設けられており、リード線埋設溝52cは、支持枠52aの側面に設けられたリード線引出孔52dにつながっている。

【0031】支持枠52aの内部には、半径方向に沿って貫通しているガス流路52eが設けられ、ガス流路52e内に反応ガスを流せるようになっている。さらに、支持枠52aの中央には、ガス流路52eと直交するように、軸方向に沿って円柱状の貫通穴52fが設けられている。

【0032】ここで、支持枠52aには、固体高分子型燃料電池40の作動温度域（80℃前後）でも変形しない程度の耐熱性、及び絶縁性を有する材料が用いられる。具体的には、ポリテトラフルオロエチレンが好適な一例として挙げられる。耐熱性を必要とするのは、支持枠52aの変形を抑制し、電極・電解質接合体42の締め付け圧力の低下や、反応ガスのシール性の低下を防止するためである。

【0033】また、絶縁性を必要とするのは、高出力電圧を得るためである。すなわち、高出力電圧を得るには、各単電池50を直列に接続する必要があるが、後述するように、図1に示す固体高分子型燃料電池40においては、単電池50が（-+）、（+-）、（-+）…の順序で並ぶので、支持枠52aとして導体を用いると、同極同士がつながり、燃料電池40が短絡するためである。

【0034】なお、高出力電圧を必要としない場合には、支持枠52aの一部にステンレス鋼等の導体を用いると共に、他の一部に絶縁体を用い、単電池50を並列接続するように構成しても良い。

【0035】ガス透過体52gは、円筒形を呈しており、支持枠52aの貫通穴52fに埋設されている。また、ガス透過体52gには、ガス透過性、凸型挟持体52と凹型挟持体54により電極・電解質接合体42を挟持した時に圧壊しない程度の強度、及び絶縁性を有する材料が用いられる。具体的には、ジルコニア等のセラミックス多孔体が好適な一例として挙げられる。

【0036】ガス透過性を必要とするのは、支持枠52aのガス流路52eを流れる反応ガスを、ガス透過体52gを介して、支持枠52aの両面に配した電極・電解質接合体42に供給するためである。

【0037】従って、図1に例示する固体高分子型燃料電池40においては、支持枠52aには、反応ガスの混合を防止するためのセパレータとしての機能はなく、電極・電解質接合体42がセパレータとしての機能を果たすようになっている。

【0038】また、強度を必要とするのは、凸型挟持体52及び凹型挟持体54により電極・電解質接合体42を挟持する際に、電極・電解質接合体42に所定の締め付け圧力を付与するためである。すなわち、ガス透過体

52gの強度が低いと、締め付け圧力を大きくすることができず、反応ガスのガス漏れが生じたり、電解質膜44とガス拡散電極46との電氣的接触が不十分となり、発電効率が低下する。

【0039】さらに、絶縁性を必要とするのは、上述の支持枠52aと同様、単電池50を直列に接続し、高出力電圧を確保するためである。但し、高出力電圧が要求されない場合には、支持枠52aと同様、一部のガス透過体52gを金属多孔体、金属メッシュの積層体等のガス透過性を有する導体で構成し、単電池50を並列接続するようにしても良い。

【0040】なお、ガス透過体52gは、電極・電解質接合体42に反応ガスが供給可能であれば足りるので、ガス透過体52gの形状は、図3に例示するように、円筒形のセラミック多孔体に限定されるものではない。

【0041】例えば、ガス透過体52gとして、円筒形のセラミック多孔体の側面に、ガス流方向に沿って貫通穴を設けたものを用いてもよい。ガス流方向に沿って貫通孔を設けると、圧力損失を低減できるという利点がある。また、ガス透過体52gとして緻密質の材料を用い、ガス流方向に沿って貫通している多数の溝を併設した、いわゆるリブ状とし、山部の先端で電極・電解質接合体42を支持するようにしても良い。

【0042】リード線52hは、電解質膜44に接合されたガス拡散電極46と接触させることにより、電極・電解質接合体42で発電された電気を取り出すためのものであり、支持枠52aの凸部52bの端面に設けられたリード線埋設溝52cに埋設される。また、リード線52hの端部は、支持枠52aの側面に設けられたリード線引出孔52dから、支持枠52a外に引き出されている。

【0043】リード線52hの材質としては、耐食性に優れた材料が用いられる。具体的には、ステンレス鋼、Sn又はSn合金、あるいはステンレス鋼、銅等の金属製のリード線にSn又はSn合金を被覆したものが好適な一例として挙げられる。

【0044】耐食性を必要とするのは、固体高分子型燃料電池40に供給される反応ガスは、通常、電解質膜44に水を補給するために加湿されており、リード線52hは、酸化水蒸気雰囲気下に曝されるが、酸化水蒸気によりリード線52hが酸化、不働態化すると、ガス拡散電極46との接触抵抗が増大し、発電効率が低下するためである。

【0045】凹型挟持体54は、図4に示すように、支持枠54aと、ガス透過体54gと、リード線54hからなっている。支持枠54aは、凹型挟持体54の基材となるものであり、円板状の基材の両端面には凹部54bが形成されている。また、凹部54bの内側面には、雌ネジが設けられ、凸型挟持体52の凸部52aの外側面に形成された雄ネジと螺合することにより、凹型挟持

体54と凸型挟持体52とを機械的に締結・一体化できるようにになっている。

【0046】また、支持枠54aの凹部54bの内径は、電極・電解質接合体42の外径よりやや大きくなっており、電極・電解質接合体42を凹部54bに収容できるようにになっている。

【0047】さらに、凹型挟持体54と凸型挟持体52を締結した時に、凹部54bの底面と凸部52bの先端面の間に空間が形成されるが、その空間の高さは、その空間内で挟持される電極・電解質接合体42に所定の締め付け圧力が付与されるよう、電極・電解質接合体42の高さより若干小さくなっている。

【0048】なお、支持枠54aの凹部54bの底面には、リード線埋設溝54cが設けられ、支持枠54aの側面に設けられるリード線引出孔54dにつながっている点、支持枠54aの内部には、半径方向に沿って貫通しているガス流路54eが設けられている点、軸方向に沿って貫通孔54fが設けられている点、支持枠54aの材質としてポリテトラフルオロエチレンが好ましい点は、凸型挟持体52の支持枠52aと同様である。

【0049】また、支持枠54aの貫通孔54fには、ガス透過体54gが埋設されている点、ガス透過体54gの材質として、ジルコニア等のセラミックス多孔体が好ましい点、リード線埋設孔54cにはリード線54hが埋設される点、リード線54hの材質として、ステンレス鋼、Sn又はSn合金線、あるいはステンレス鋼、銅等の金属線にSn又はSn合金を被覆したものが好適である点も、凸型挟持体52と同様である。

【0050】端子板56は、図5に示すように、積層された単電池50の両端に配置された凸型挟持体52の凸部52bと螺合できるように、雌ねじ56aが設けられている。また、端子板56には、ステンレス鋼、銅等の導電性の材料が用いられる。

【0051】なお、端子板56は、各電極・電解質接合体42で発電された電気を取り出すことができれば足りるので、必ずしも凸型挟持体52と螺合させる必要はなく、単にはめ込むようにしても良い。また、単電池50の積層体のいずれか一方の端部が凹型挟持体54である場合には、凹部54bの雌ねじと螺合可能な雄ねじ、あるいははめ込み可能な凸部を設けたものを端子板56として用いても良い。

【0052】次に、図1に示す固体高分子型燃料電池40の組み立て手順について説明する。まず、ガス透過体54g及びリード線54hが埋設された凹型挟持体54の凹部54bに電極・電解質接合体42を収容する。次いで、同じくガス透過体52g及びリード線52hが埋設された凸型挟持体52の凸部52bを凹型挟持体54の凹部54bに臨ませ、凸部52bと凹部54bを螺合すればよい。

【0053】これにより、電極・電解質接合体42は、

凸部52bの先端面及び凹部54bの底面により所定の締め付け圧力が均一に付与される。また、この時、リード線埋設孔52c、54cに埋設されたリード線52h、54hと、電極・電解質接合体42のガス拡散電極46、46とが接触して、一つの単電池50となる。

【0054】2つ目以降の単電池50の締結作業も同様であり、既に締結された凹型挟持体54の他方の凹部54bに、電極・電解質接合体42を収容し、電極・電解質接合体42が収容された凹部54bに、別の凸型挟持体52の凸部52を螺合させるだけでよい。そして、所定数の単電池50を積層した後、両端に端子板56を螺合すれば、単電池50の積層体が得られる。

【0055】次に、リード線52h、54hの結線を行う。通常は、高出力電圧が得られるように、各単電池50は、直列に接続される。図1に例示する固体高分子型燃料電池40の場合、凸型挟持体52のガス流路52eには燃料ガスを流し、凹型挟持体54のガス流路54eには空気を流すようになっているので、凸型挟持体52と接するガス拡散電極46がアノード（一極）となり、凹型挟持体54と接するガス拡散電極46がカソード（+極）となる。

【0056】すなわち、単電池50は、（-+）、（+-）、（-+）…のように、同極同士が隣り合うようになっている。従って、単電池50を直列に接続するためには、例えば、上部の端子板56には、最上部に位置する単電池50のアノード側のリード線52hと結線して一極とし、下部の端子板56には、最下部に位置する単電池50のカソード側のリード線54hと結線して+極とし、さらに各単電池50が（+-）、（+-）、…の順序でつながるように、残りのリード線52h、54hを結線すればよい。

【0057】最後に、ガス流路52gに燃料マニホールド（図示せず）を取り付け、ガス流路54gに空気マニホールド（図示せず）を取り付ければ、固体高分子型燃料電池40が完成する。

【0058】このような構成を有する固体高分子型燃料電池40のガス流路52e及び54eに、それぞれ、改質ガス等の水素を含む燃料ガス及び空気を流せば、凸部52bと接しているガス拡散電極46には燃料が供給され、凹部54bと接しているガス拡散電極46には空気が供給される。これにより、各電極・電解質接合体42において電極反応が進行し、得られた電気は、端子板56、56を介して外部に取り出される。

【0059】なお、各単電池50の一部を並列接続する場合には、リード線52h、54hの結線順序を変えても良いが、支持枠52a、54a及びガス透過体52g、54gの一部に導体を使用し、同極同士の一部をつなぐようにしても良い。この場合、支持枠52a、54a及びガス透過体52h、54hがリード線の役割を果たすので、リード線52h、54hは不要である。

【0060】また、組み立てられた燃料電池を分解する場合には、上述とは逆の手順で行えば良い。さらに、一部の単電池50のみを交換する場合には、交換したい単電池50を構成する挟持体52、54のみを取り外すだけでよい。

【0061】次に、本発明の第2の実施の形態に係る固体高分子型燃料電池について説明する。図6は、本発明の第2の実施の形態に係る固体高分子型燃料電池60の分解断面図である。図6において、固体高分子型燃料電池60は、電極・電解質接合体42と、一方の面に凸部62bを有し、他方の面に凹部62dを有する挟持体62とを備えている。

【0062】固体高分子型燃料電池60は、電極・電解質接合体42と挟持体62が積層方向に向かって交互に積層された構造になっている。また、隣接する一方の挟持体62の凸部62bと他方の挟持体62の凹部62dとは、機械的締結手段により締結・一体化できようになっている。図6に例示する固体高分子型燃料電池60においては、機械的締結手段として、ネジ止めによる螺合手段が用いられている。

【0063】また、電極・電解質接合体42は、一方の挟持体62の凸部62b先端面と、他方の挟持体62の凹部62d底面との間で挟持されるようになっており、2つの挟持体62、62及び電極・電解質接合体42により、1つの単電池50が構成される。なお、図6に例示する固体高分子型燃料電池60においては、単電池50が4層積層された構造になっているが、単電池を5層以上積層する場合も同様である。

【0064】電極・電解質接合体42は、図2に示すものと同一の構成を有しているので説明を省略する。また、挟持体62は、図7に示すように、支持枠62aと、ガス透過体62i、62jとを備えている。

【0065】支持枠62aの一方の面に設けられた凸部62bには、絶縁層62cが設けられ、凸部62bの先端面の一部、外側面及び基底面が絶縁層62cにより覆われている。これは、挟持体62、62同士を螺合した時に、挟持体62、62同士の絶縁を確保すると同時に、絶縁層62cに覆われていない凸部62b先端面とガス拡散電極46とを接触させるためである。また、絶縁層62cの外周面には、雄ネジが設けられている。

【0066】また、支持枠62aの他方の面に設けられた凹部62dの内周面には、絶縁層62cの外周面に設けられた雄ネジと螺合可能な雌ネジが設けられている。また、凹部62dの外径は、電極・電解質接合体42の外径よりやや大きくなっており、電極・電解質接合体42を凹部62d内に収容できるようになっている。

【0067】さらに、2つの挟持体62、62を締結したときに、凹部62dの底面と凸部62bの先端面の間に空間が形成されるが、その空間の高さは、その空間内で挟持される電極・電解質接合体42に所定の締め付け

圧力が付与されるよう、電極・電解質接合体42の高さより若干小さくなっている。

【0068】支持枠62aの内部には、半径方向に向かって貫通し、互いに交差している2つのガス流路62e、62fが設けられ、一方に燃料ガスを、他方に酸化剤ガスを流せるようになっている。従って、本実施の形態の場合、単電池50は、(+-)、(+-)…のように、異極同士が隣り合うように積層される。また、挟持体62は、セパレータとしての機能も果たすようになっている。

【0069】さらに、支持枠62aの凸部62b側には、ガス流路62eのみと連通するガス透過体埋設孔62gが設けられ、支持枠62aの凹部62d側には、ガス流路62fのみと連通するガス透過体埋設孔62hが設けられている。

【0070】ここで、支持枠62aには、導電性及び耐食性を有する材料が用いられる。具体的には、ステンレス鋼、Sn又はSn合金、あるいはステンレス鋼、銅等からなる基材にSn又はSn合金を被覆したもの等が好適な一例として挙げられる。

【0071】導電性を必要とするのは、挟持体62の両端に配置する電極・電解質接合体42、42のガス拡散電極46、46を電氣的に接続し、単電池50を直列に接続するためである。従って、図7に示す挟持体62の場合、図3及び図4に示す挟持体52、54と異なり、リード線は不要である。

【0072】また、耐食性を必要とするのは、支持枠62aが酸化水蒸気雰囲気下に曝されることにより酸化、不働態化すると、ガス拡散電極46との接触抵抗が増加し、発電効率が低下するためである。

【0073】支持枠62aの凸部62bに設けられる絶縁層62cには、固体高分子型燃料電池60の作動温度(80℃前後)でも絶縁特性を維持できる程度の耐熱性を有する材料が用いられる。具体的には、ポリテトラフルオロエチレンが好適な一例として挙げられる。また、支持枠62aと、絶縁層62cとは、ネジ止め、ボルト止め、嵌合等の手段を用いて、固定すればよい。

【0074】ガス透過体62i及び62jは、円筒形を呈しており、それぞれ、支持枠62aに設けられたガス透過体埋設孔62g及び62hに埋設されている。また、ガス透過体62i及び62jには、それぞれ、ガス流路62e及び62f方向に向かって貫通している貫通孔62k及び62lが設けられている。

【0075】ここで、ガス透過体62i及び62jには、ガス透過性及び2つの挟持体62、62により電極・電解質接合体42を挟持した時に圧壊しない程度の強度を有する材料が用いられる。ガス透過性及び強度を必要とするのは、図3及び図4に示す挟持体52、54に用いられるガス透過体52g、54gと同様の理由による。

【0076】但し、本実施の形態の場合、単電池50が(+-)、(+-)…の順序で積層されるので、ガス透過体62i及び62jは、絶縁体である必要ではなく、導体を用いても良い。具体的には、ジルコニア等のセラミックス多孔体や、金属多孔体、金属メッシュの積層体等を用いることができる。

【0077】なお、ガス透過体62i及び62jには、貫通孔62k及び62lを有しない多孔体を用いても良く、また緻密質の材料からなるリブ状のものを用いても良い点は、図3及び図4に示すガス透過体52g、54gと同様である。

【0078】次に、図6に示す固体高分子型燃料電池60の組み立て手順について説明する。まず、ガス透過体62i、62jが埋設された一方の挟持体62の凹部62dに電極・電解質接合体42を収容する。次いで、同じくガス透過体62i、62jが埋設された他方の挟持体62の凸部62bを、一方の挟持体62の凹部62dに臨ませ、凸部62bと凹部62dと螺合すればよい。

【0079】これにより、電極・電解質接合体42は、凸部62bの先端面及び凹部62dの底面により所定の締め付け圧力が均一に付与される。また、この時、一方の挟持体62の凸部62b先端面の内、絶縁層62cに覆われていない部分と電極・電解質接合体42の一方のガス拡散電極46とが接触し、他方の挟持体62の凹部62d底面と電極・電解質接合体42の他方のガス拡散電極46とが接触して、一つの単電池50となる。

【0080】2つ目以降の単電池50の締結作業も同様であり、既に締結された挟持体62の凹部62dに、電極・電解質接合体42を収容し、電極・電解質接合体42が収容された凹部62dに別の挟持体62の凸部62bを螺合させるだけでよい。

【0081】さらに、所定数の単電池50を積層した後、最後にガス流路62eに燃料マニホールド(図示せず)を取り付け、ガス流路62fに空気マニホールド(図示せず)を取り付ければ、固体高分子型燃料電池60が完成する。

【0082】このような構成を有する固体高分子型燃料電池60のガス流路62e及び62fに、それぞれ、改質ガス等の水素を含む燃料ガス及び空気等の酸素を含む酸化剤ガスを流せば、凸部62bと接しているガス拡散電極46は、ガス透過体62iを介して燃料ガスが供給されてアノード(一極)となり、凹部62dと接しているガス拡散電極46は、ガス透過体62jを介して空気が供給されてカソード(+極)となる。これにより、各電極・電解質接合体42において電極反応が進行し、得られた電気は、両端に配した導体制の挟持体62、62を介して外部に取り出される。

【0083】なお、組み立てられた燃料電池を分解する場合は、上述とは逆の手順で行えば良い点、及び一部の単電池50のみを交換する場合には、交換したい単電池

50を構成する挟持体62、62のみを取り外せば良い点は、第1の実施の形態と同様である。

【0084】以上、本発明の実施の形態について詳細に説明したが、本発明は上記実施の形態に何ら限定されるものではなく、本発明の要旨を逸脱しない範囲内で種々の改変が可能である。

【0085】例えば、上記実施の形態では、いずれも機械的締結手段として螺合手段を用いているが、一方の挟持体に設けられる凸部外側面と他方の挟持体に設けられる凹部内側面のいずれか一方に突起を設けると共に、他方にその突起と係合する溝を設け、一方の挟持体の凸部を他方の挟持体の凹部にはめ込むと同時に、突起と溝とを係合させることにより、隣接する挟持体同士を締結するようにしても良い。

【0086】また、第1の実施の形態においては、両面に凸部を設けた凸型挟持体と、両面に凹部を設けた凹型挟持体を用いて電極・電解質接合体を挟持するようになっているが、支持枠の一方の面に凸部を設け、他方の面に凹部を設けた挟持体を用いても良い。

【0087】また、第1の実施の形態においては、リング状のリード線を電極・電解質接合体に接触させるようにしているが、支持枠の凸部52b先端及び凹部54b底面、並びにガス透過体52g、54gの両端面に渦巻き状の溝を設け、渦巻き状のリード線を埋設するようにしても良い。あるいは、リード線の代わりに、金属メッシュ等のガス透過性を有する薄層状の導体を電極・電解質接合体の両面に接触させ、薄層状の導体を介して発電された電気を取り出すようにしても良い。

【0088】また、上記実施の形態では、単電池のみが積層された構造について説明したが、単電池を数セル積層する毎に冷却板を配置するようにしても良い。さらに、上記実施の形態では、支持枠の外形をいずれも円筒形としているが、支持枠の外形を角柱状等、他の形状としても良く、これにより上記実施の形態と同様の効果を得ることができる。

【0089】

【発明の効果】本発明に係る燃料電池は、電極・電解質接合体を、ガス流路を備えた挟持体で挟持すると共に、挟持体同士を機械的締結手段により締結するようにしたので、単電池を数百セル積層して、ボルトで一括して締め付ける従来型の固体高分子型燃料電池に比較して、組み立てが容易になり、工数も少なくすることができ、製造コストを削減することができるという効果がある。

【0090】また、各電極・電解質接合体毎に締め付け作業が行われるので、各電極・電解質接合体を均一な圧力で締め付けることが可能となり、単電池間の特性差が少なくなるという効果がある。

【0091】さらに、燃料電池を組み立てた後、一部の単電池に異常が発生した場合には、異常が発生した部位の挟持体の締結を解除し、異常が発生した電極・電解質

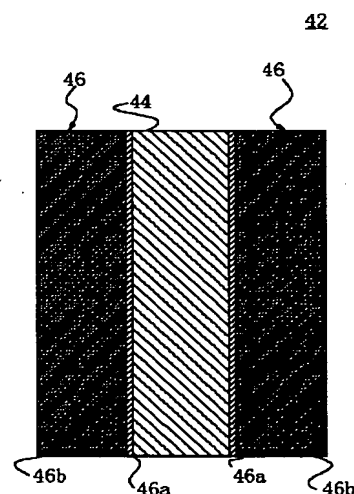
【００９２】以上のように、本発明は、単電池間の特性差が少なく、保守作業の容易な燃料電池を安価に製造することを可能とするものである。そのため、これを例えば自動車用の燃料電池システムに応用すれば、自動車の高出力化、低コスト化に寄与するものであり、産業上その効果の極めて大きい発明である。

【図6】本発明の第2の実施の形態に係る固体高分子型

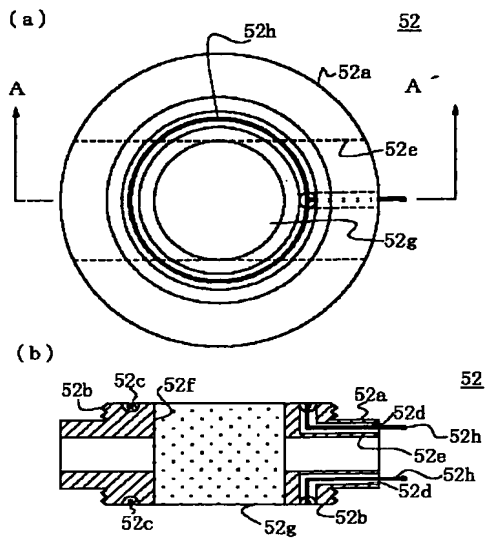
【符号の説明】

4 0、6 0	固体高分子型燃料電池
4 2	電極・電解質接合体
4 4	固体高分子電解質膜（電解質膜）
4 6	ガス拡散電極
5 0	単電池
5 2	挟持体（凸型挟持体）
5 2 e	ガス流路
5 4	挟持体（凹型挟持体）
5 4 e	ガス流路
6 2	挟持体
6 2 e、6 2 f	ガス流路

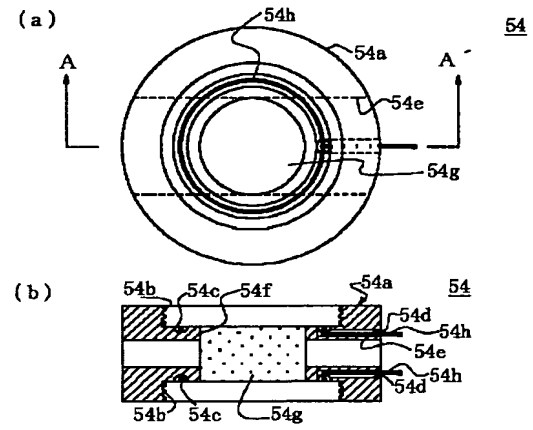
【図 2】



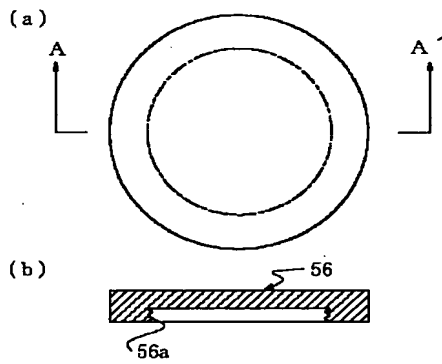
【図3】



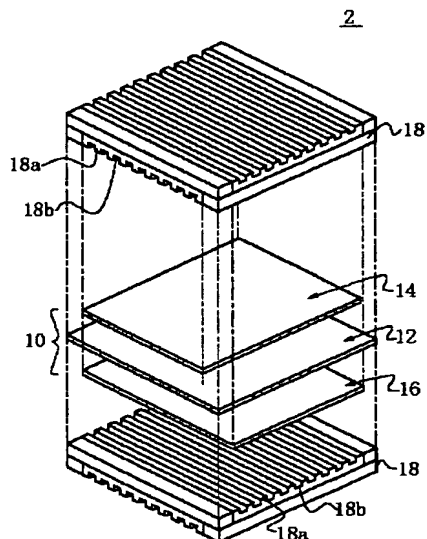
【図4】



【図5】



【図8】



【図6】

